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EVALUATION PROGRAM FOR RADIOACTIVE WASTE INCINERATION (SUPPLEMENT)

PART I: RESULTS OF CONTRACTUAL PERFORMANCE TESTS
PART II: PROPOSED ENGINEERING EVALUATION
PART III: PROPOSED RADIOLOGICAL AND ISOTOPIC EVALUATION

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ABSTRACT

A 50-lb/hr incinerator and associated gas-cleaning equipment for the concentration of low-level radioactive waste has been designed and fabricated under joint sponsorship of the US Army Nuclear Defense Laboratory (USANDL) and the US Atomic Energy Commission, AEC Agreement 18-62.

Part I of this technical memorandum reports the results of contractual performance tests. All items met overall performance test requirements except the air-dilution valve, which was rejected because of leakage in excess of specified limits. To replace the rejected item, USANDL personnel designed, fabricated, installed, and tested a new air-dilution system. Although other minor deficiencies were noted during these tests, they were readily corrected by USANDL personnel.

Part II of this technical memorandum delineates the engineering evaluation program presently being conducted. Techniques being evaluated include the use of overfire auxiliary air, continuous auxiliary gas fuel, combustion temperatures up to 2500°F, and dry collection methods for effluent gas-cleaning.

Part III briefly outlines the objectives and procedures to be employed during the radiological and isotopic evaluation. The entire radiological evaluation program and results of Part III will be issued as a separate report.

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AN EVALUATION PROGRAM FOR RADIOACTIVE WASTE INCINERATION (SUPPLEMENT)

INTRODUCTION

With the US Army's increased participation in nuclear activities, its requirements for practical and economic disposal of radioactive wastes have necessitated studies in incineration as a means of concentrating and disposing of combustible radioactive wastes. The Department of the Army has assigned the responsibility for radioactive waste disposal to the support services Depot Operations Division of Edgewood Arsenal. USANDL, under the assigned responsibility for conducting research in radioactive-waste disposal, has been requested to study and recommend disposal methods for these wastes.

USANDL and the Atomic Energy Commission (AEC) are co-sponsoring an evaluation program for this 50-lb/hr incinerator and associated gas-cleaning equipment for the concentration of low-level radioactive combustible waste. This experimental facility was designed and fabricated under joint sponsorship of the AEC and USANDL, AEC Agreement 18-62, to develop an economic incineration system to satisfy US Army and AEC requirements.

Design of the 50-lb/hr incinerator was based on the evaluation of the ACL II (Reference 2 and 3), a 25-lb/hr incinerator developed by the Harvard University Air Cleaning Laboratory (ACL) after having conducted, under AEC contract, an extensive stack-sampling and experimental program on the Bureau of Mines unit. The ACL II featured tangential overfire air and a secondary combustion chamber, since previous AEC studies conducted by the Bureau of Mines (Reference 1) had concluded that uniform combustion rates and maximum combustion efficiency were best achieved by use of a tangential overfire air supply.

Techniques being evaluated under the program include the use of overfire auxiliary air, continuous auxiliary gas fuel, combustion temperatures up to 2500°F, and effluent dry-cleaning methods. The evaluation program consists of three phases: Part I, contractual performance and evaluation; Part II, engineering testing and evaluation; and Part III, radiological and isotopic evaluation. Part I has been completed and the results of these tests are discussed in this memorandum. Part II, outlined in this memorandum, is now in progress. A separate report covering Part III will be issued at a later date.

Part I CONTRACTUAL PERFORMANCE TESTS

1. BACKGROUND

1.1 Description of Facility.

1.1.1 Incinerator. The experimental (Reference 4) incinerator, Figure 1.1, consists of a primary and secondary combustion chamber constructed of mild steel, and lined with 2-1/2-inch-thick insulating-type refractory.

Primary overfire air is admitted tangentially into the primary combustion chamber through two openings approximately 155 degrees apart and 24 inches above the grate. The primary air inlets consist of 3-inch stainless steel pipes into which specially shaped, annular-pipe sections may be inserted so that the effects of velocity variation at constant volumetric flow rate may be studied. Two sets of air inlets, constructed as panel insert sections, are provided. One pair is for tangential, horizontal air admission; the other is for directing inlet air tangentially downward at a 30-degree angle relative to the horizontal.

Secondary combustion air is admitted tangentially through a single 2-inch pipe, 6-3/8 inches above the base of the secondary combustion chamber. Annular inserts are again provided to permit velocity variation.

The incinerator utilizes continuous auxiliary gas-firing in both combustion chambers to minimize discharge of unburned materials, and to maintain desired operating temperatures up to 2500°F. The auxiliary gas-firing system also serves to preheat the combustion chambers prior to the charging of waste.

Waste material is introduced as packaged charges, 6 to 10 pounds at a time, through a side-loading door (Figure 1.2). A three-pronged sliding fork, inserted through the loading door, permits temporary suspension of wet packaged charges above the grate to facilitate rapid drying. A manually operated protective guillotine door, in conjunction with a totally inclosed charging lock, is provided to eliminate exposure of operating personnel to accidental release of dust or fumes during the charging operation.

Ashes drop through grate openings into a conical ash receiver and are discharged through a rotary valve into a 55-gallon drum for storage. A hydraulic jack maintains a tight air seal between the drum rim and the rotary valve.

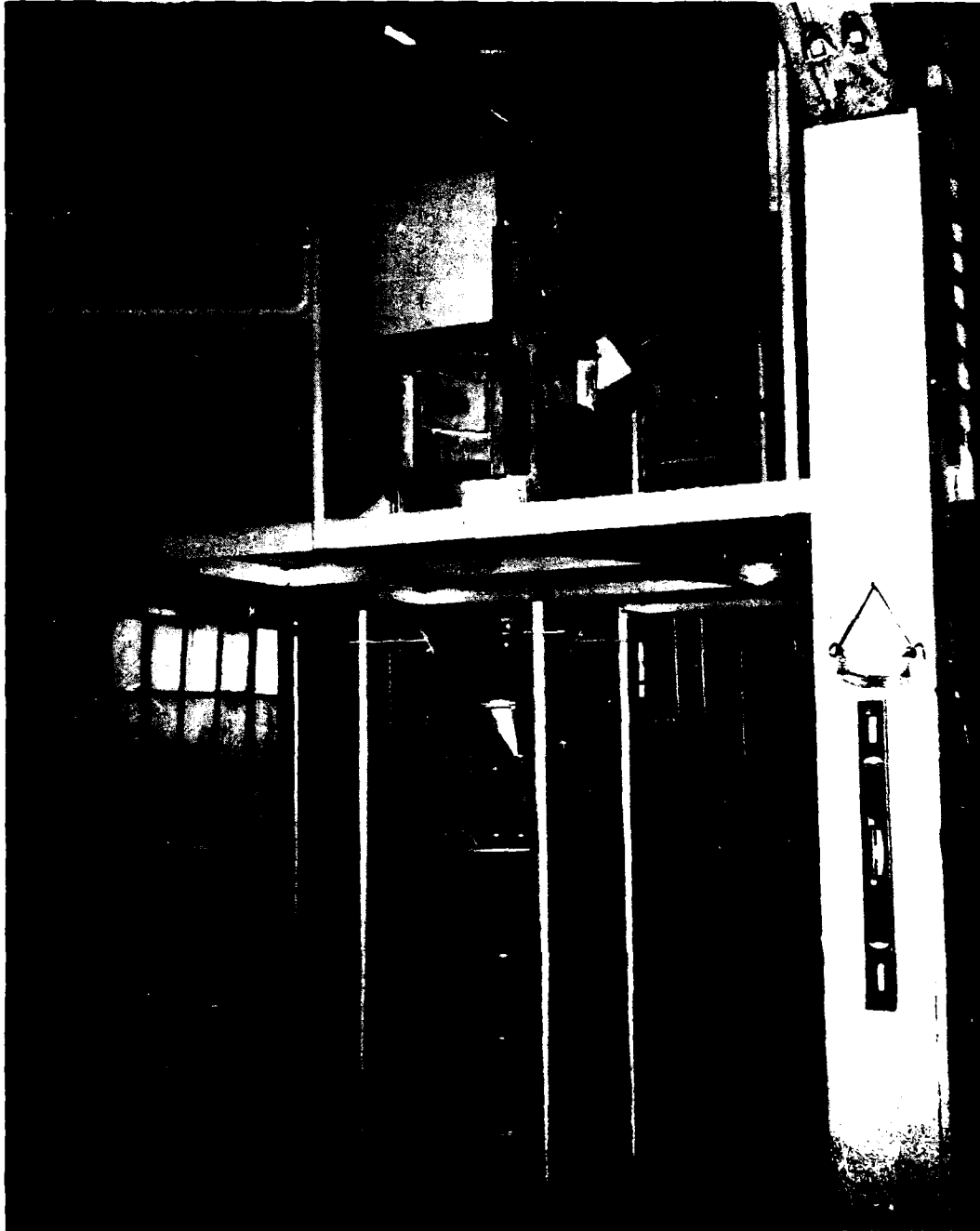


Figure 1.1 Incinerator for disposal of low-level radioactive waste with charging lock and one air inlet panel removed.

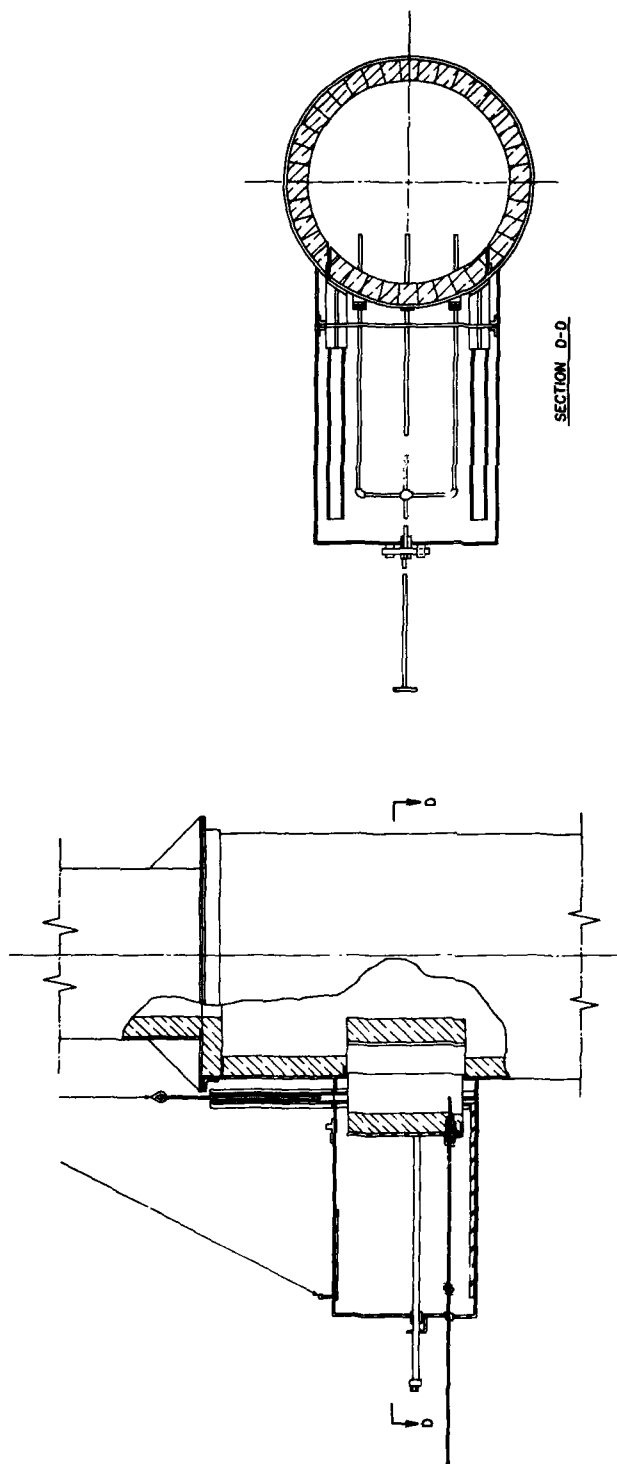


Figure 1.2 Charging lock.

Hot combustion gases exit tangentially from the secondary combustion chamber, and are cooled by dilution with ambient air before they enter the gas-cleaning equipment. (Figure 1.3)

1.1.2 Gas-Cleaning Equipment. Cooled combustion gases, after leaving the incinerator and passing through the air-dilution valve, enter a medium-velocity, involute-cyclone separator which removes coarse entrained particulate. The cyclone also provides extended cooling surface for gas-temperature reduction. Collected particulate is discharged through a slide valve into a 55-gallon drum. The slide valve permits continuous operation of the gas-cleaning system while drums are being changed. A hydraulic jack maintains a tight air seal between the drum rim and the cyclone bottom. Screw jacks are employed as a safety measure in the event of hydraulic failure.

Effluent from the cyclone enters a Cottrell-type electrostatic precipitator for removal of fine solid particles, soot, mineral dust, and tar droplets formed by condensation of volatile organic vapors. The precipitator is designed to apply a high negative charge to the gas-borne particles and collect the charged particles on grounded metal plates.

The particles are charged by rows of vertical wires mounted in parallel frames, 4 inches apart. The frames are connected to the negative terminal of a variable 30,000-volt DC power supply. The wires are cleaned by vibrators connected to the frames through nonconductive shafts. Dust shaken from the wires falls into a hopper. The grounded collector plates are parallel to the rows of wires in an alternate array and are cleaned by a rapper mechanism which lightly raps the bottom plate support to release the dust particles; this dust also falls into the hopper. Gas flow is parallel to the wire frames and collector plates. The collected dust is discharged through a slide valve into a 55-gallon drum beneath the hopper. The slide valve allows continuous operation of the precipitator while the drums are being changed. A hydraulic jack maintains a tight air seal between the drum rim and hopper bottom. As with the cyclone, screw jacks are employed as a safety measure. The precipitator is cleaned only when the remainder of the facility is inoperative; otherwise dust would be carried into the filter bank.

Gas leaving the precipitator enters a filter bank of two high-efficiency mineral-fiber filters. The unit is designed to collect particulate blow-off from the electrostatic precipitator and to provide limited emergency protection in the event of electrical power failure or precipitator malfunction. The unit accepts filters 24" x 24" up to 12" deep.

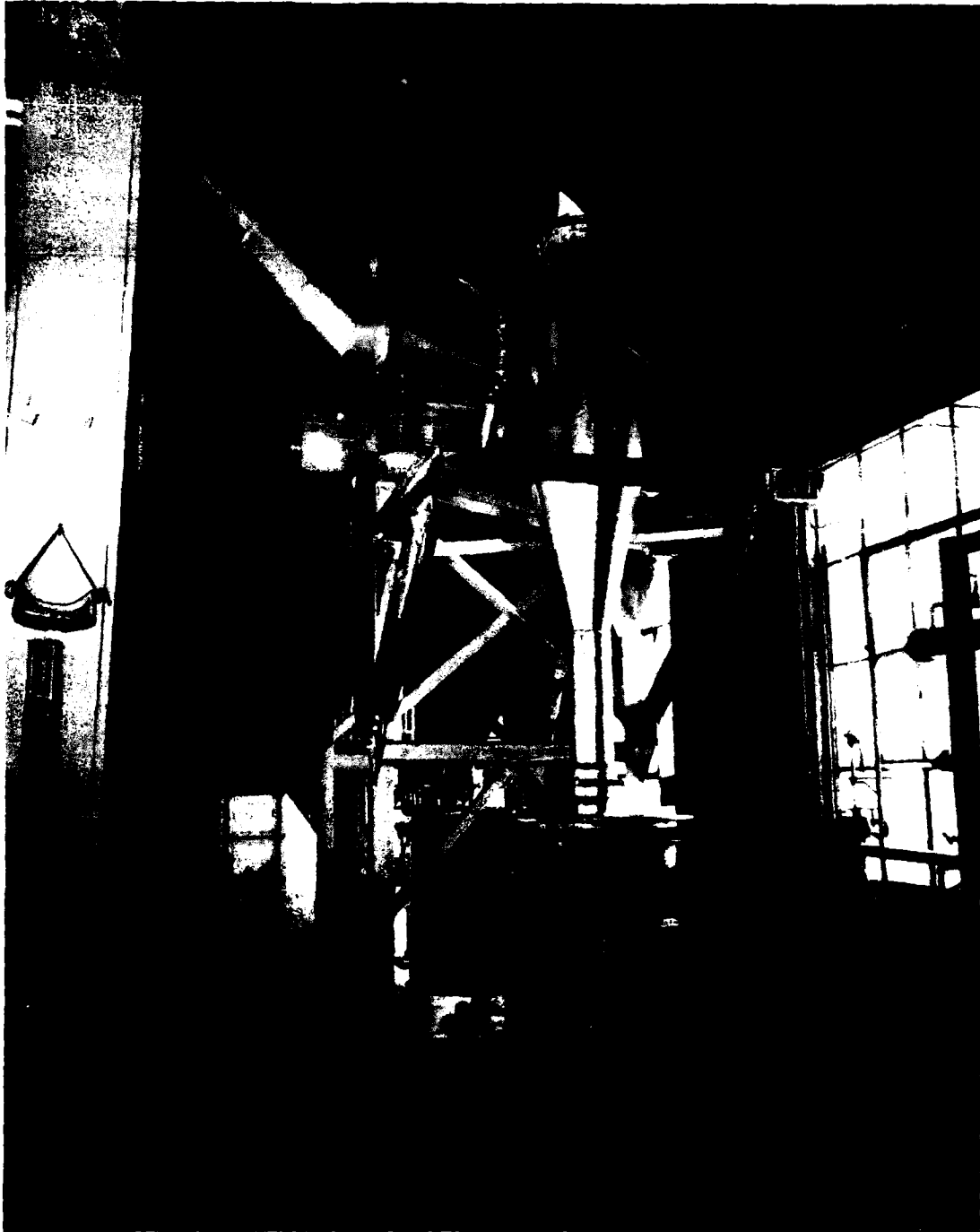


Figure 1.3 Gas-cleaning system.

2. PERFORMANCE TESTS

Before the engineering evaluation was started, performance characteristics of the facility as dictated by contractual agreement were determined. The tests were concerned with leakage, gas-handling capacity, and overall gas-cleaning efficiency of the cyclone and electrostatic precipitator.

Specifics on the contractual performance test requirement are given in section 3.2 of Reference 5. Results, discussions, and conclusions of these tests follow.

2.1 System Gas-Handling Capacity and Leak Tests at Ambient Temperatures.

2.1.1 Air Leakage up to Exhauster Inlet. These tests were conducted to determine total system air leakage up to the exhauster inlet. Flow rates were held to the specified ± 10 percent values. Test data obtained are shown in Table 2.1.

TABLE 2.1 AIR LEAKAGE TO EXHAUSTER INLET AT 70°F

Item	Specified	Actual
Primary air No. 1, cfm STP	75	69
Primary air No. 2, cfm STP	75	74
Secondary air, cfm STP	40	40
Dilution air, cfm STP	810	820
Exhauster inlet, cfm STP	1050	1020
Leakage, percent	5	2

Since no method of measuring dilution air rate directly was known at the time these tests were conducted, the rate was determined by subtracting the sum of the primary and secondary air rates from the total air-flow measured by a pitot-static traverse into the cyclone. Results of tests were within specified limits; the cyclone, electrostatic precipitator, and final filter were thus shown to be sufficiently leak-tight and were approved on this basis.

2.1.2 Air Leakage to Cyclone Inlet. Two tests were conducted to determine leakage through the charging assembly (charge box plus guillotine) and air-dilution valve. The air-dilution valve could not be completely closed because of poor fabrication; obviously, this would result in excessive leakage.

The first test consisted of sealing the entire charge-box assembly with tape and polyethylene film to determine air leakage attributable to the closed air-dilution valve. Test data are shown in Table 2.2.

TABLE 2.2 AIR LEAKAGE TO CYCLONE INLET AT 70°F (Sealed)

Item	Specified	Actual
Primary air No. 1, cfm STP	75	75
Primary air No. 2, cfm STP	75	74
Secondary air, cfm STP	40	40
Cyclone inlet, cfm STP	205	870
Total air-inlet flow, cfm STP	190	189
Dilution valve leakage, cfm STP	15	681
*Leakage, percent	7.9	360

*Based on inlet-air measurement.

In the second test, the charge-box assembly was unsealed and the total air leakage through the charge-box assembly and closed air-dilution valve was measured. Test data are shown in Table 2.3.

Again, since no method was known of directly measuring dilution-air flow rates, these values were obtained by subtracting the total air-inlet flow to the incinerator from the total air inlet flow to the cyclone.

TABLE 2.3 AIR LEAKAGE TO CYCLONE INLET AT 70°F (Unsealed)

Item	Specified	Actual
Primary air No. 1, cfm STP	75	65
Primary air No. 2 cfm STP	75	65
Secondary air, cfm STP	40	34
Cyclone inlet, cfm STP	205	850
Total air-inlet flow, cfm STP	190	164
Total air leakage, cfm STP	15	686
Leakage, percent	7.9	420

Since the exhaustor is essentially a constant-volume device at constant fan speed, the difference in flow measured at the cyclone inlet was assumed to be within the limits of accuracy of a pitot-static traverse. On the basis of these two tests, leakage was attributed to the air-dilution valve, alone, and to the charge-box assembly and the air-dilution valve, together.

Air leakage of 360 percent was measured in the first test, with the closed air-dilution valve and the charging assembly sealed. Removal of the tape and the polyethylene film in the second test resulted in a 25-cfm decrease in air-inlet flow to the incinerator and air leakage of 416 percent based on the total air-inlet flow. Leakage attributed to the charge-box guillotine-door assembly is assumed to be the 25-cfm decrease in air-inlet flow. Charge-box leakage based on inlet airflow was 15 percent.

Although charge-box leakage of 15 percent occurred during the above test, minor modifications reduced this figure to an acceptable value of approximately 5 percent. On this basis, the entire charging assembly was accepted. The air-dilution valve, however, was rejected on the basis of leakage in excess of specified limits. The unsatisfactory performance necessitated a major modification of the air-dilution system. A new air-dilution system, designed and fabricated by USANDL personnel, was installed after completion of these acceptance tests. A description of the new system is included in section 3 of this memorandum.

2.2 System Gas-Handling Capacity and Leak Tests at 2000°F. These tests were conducted to determine total-system gas leakage at 2000°F exit-gas temperature from secondary combustion chamber.

Because of the excessive leakage of the air-dilution valve, the total flow through the system could be maintained only by closing the air-dilution valve as much as possible or by raising the gate valve at the exhauster. Either technique resulted in a decrease in furnace temperature; the best condition that could be attained was a compromise between air-inlet flow rates and dilution-air rates. Under this condition, air leakage at the exhauster inlet measured 5 percent; however, total airflow was only 43 percent of the specified value.

Since results of the leak tests at ambient temperatures were within the specified limits, results of leak tests from the cyclone inlet to the exhauster inlet were considered to be within acceptable limits.

2.3 Total Gas Leakage up to Cyclone Inlet for Incinerator Exit-Gas Temperature of 1000°F. Because of the dilution-valve leakage described previously, total gas-leakage tests up to the cyclone inlet were not conducted. Even with the air-dilution valve closed, leakage up to the cyclone inlet would be at least equal to the value cited in Table 2.4 and would be unacceptable.

TABLE 2.4 SYSTEM GAS-HANDLING CAPACITY AND LEAK TESTS AT 2000°F EXIT-GAS TEMPERATURE FROM SECONDARY COMBUSTION CHAMBER

Item	Specified	Actual
Exit temperature, °F	2000	1940
Primary burner gas, cfm STP	1.8	2.04
Primary burner air, cfm STP	45	49.1
Secondary burner gas, cfm STP	0.9	0.72
Secondary burner air, cfm STP	22.5	22.1
Primary air No. 1, cfm STP	41.5	9
Primary air No. 2, cfm STP	41.5	10
Secondary air, cfm STP	33	7
Dilution air, cfm STP	814	310
Cyclone inlet, cfm STP	1000	410
Exhauster inlet, cfm STP	1050	430
Air leakage, percent	5	5

2.4 Cyclone Performance.

2.4.1 Resistance Characteristics. These tests were conducted to determine the pressure drop across the cyclone. Data were obtained during tests described previously in sections 2.2 and 2.3 and are shown in Table 2.5.

TABLE 2.5 CYCLONE RESISTANCE* CHARACTERISTICS

Item	Specified	Actual
Resistance, inches of water (from section 3.2.1)	3.0	2.36
Resistance, inches of water (from section 3.3)	4.0	3.8

*Cyclone resistance corrected to 1000 cfm STP.

Cyclone-resistance characteristics observed during these tests were within the specified limits.

2.4.2 Weight-Collection-Efficiency Test. This test was conducted to determine the overall weight-collection efficiency of the cyclone. Controlled amounts of Cottrell-precipitated fly ash were injected and uniformly dispersed into the cyclone inlet. Test data are shown in Table 2.6.

TABLE 2.6 CYCLONE COLLECTION EFFICIENCY

Item	Specified	Actual
Air inlet flow to cyclone cfm STP	760	760
Fly ash concentration, grains/ft ³	1-2.0	1.72
Fly ash mean size, microns	12-15	7.1
Weight-collection efficiency, percent	95	82

The cyclone performed favorably under the conditions of gas flow and dust concentration shown in the test data.

Specified particle size measurements by microscopic techniques were not performed on the inlet and outlet filter samples since the samples showed considerable particulate agglomeration. Unless complete redispersion of the particulate were attained, the data would not be of significant value to determine fractional collection efficiency. However, typical fractional efficiency curves for cyclones indicate that the obtained efficiency could validly be extrapolated to the specified efficiency of 95 percent for particles having a terminal velocity equivalent to a 20-micron-diameter sphere of specific gravity 2.0. Cyclone weight efficiency was, therefore, determined to be acceptable.

2.5 Electrostatic Precipitator Performance. This test was conducted to determine the weight-collection efficiency of the electrostatic precipitator under actual incineration conditions. The incinerator was loaded with mixed charges of sawdust and animal carcasses. Test data, averaging over 6 hours, are shown in Table 2.7.

TABLE 2.7 PRECIPITATION PERFORMANCE

Item	Specified	Actual
Primary burner air, cfm STP	50	49
Primary burner gas, cfm STP		2.06
Secondary burner air, cfm STP	20	22
Primary auxiliary air No. 1, cfm STP	25	14
Primary auxiliary air No. 2, cfm STP	25	13
Secondary auxiliary air, cfm STP	20	9
Mid-brick temperature, °F	750	490
Incinerator outlet temperature, °F	2200-2500	1820
Cyclone inlet temperature, °F	750	535
Charge weight*, lb	5	5
Gross charging rate, lb/hr	50	57.8
ESP inlet dust concentration, grains ft ⁻³ STP		0.0536
ESP output voltage, kV		15
ESP collection efficiency, percent	98	98.2
Flow rate through ESP, cfm STP		690

*Charge composition: Mixed cardboard, sawdust, and animal carcasses.

Although incinerator-operating conditions varied from specified conditions, the charges burned satisfactorily. The ESP output voltage was varied up to 25 kV. Collection efficiency did not increase significantly above 15 kV; hence the optimum operating voltage was established at this level. The ESP collection efficiency was within specified limits.

3. AIR DILUTION SYSTEM MODIFICATION

As the result of poor fabrication, excessive leakage, and unsatisfactory operational control, a new air-dilution system was designed, fabricated, and installed to replace the rotating-sleeve dilution valve. The new system consists of an 8-inch duct containing an orifice plate and butterfly valve followed by an air-mixing chamber with an attached air-transition section flanged to the 8-inch duct.

Dilution air is drawn into the system by the exhauster through the inlet duct and enters the mixing chamber where it combines with the hot incinerator effluent.

The mixing chamber, shown in Figure 3.1, is fabricated from mild steel and is totally enclosed to eliminate leakage. The cylindrical chamber is approximately 15 inches long by 15 inches in diameter. The transition section which tangentially joins the mixing chamber is horizontally bisected by a curved baffle plate to divide the flow of dilution air entering the section. The upper stream enters the top of the mixing chamber tangentially and follows the contour of the outer wall, thus surrounding the hot gases leaving the incinerator. The curvature of the baffle forces the lower stream to spiral directly into the hot gas stream. The combined effect is a spiral mixing of the hot flue gas and cool dilution air, resulting in a uniformly mixed gas stream at a temperature within the design limits of the gas-cleaning system. Patent application EAPI-117, dated 5 April 1965, has been submitted for the abovementioned system.

The butterfly valve and orifice plate are used to control and measure dilution air rates.

Part II PROPOSED ENGINEERING EVALUATION

4. BACKGROUND

This part of the evaluation will be concerned with studying and defining the operating conditions that result in the most efficient operation of the system. These tests will utilize combustible charges that are radioactively "cold" but similar to the types of waste that the system was

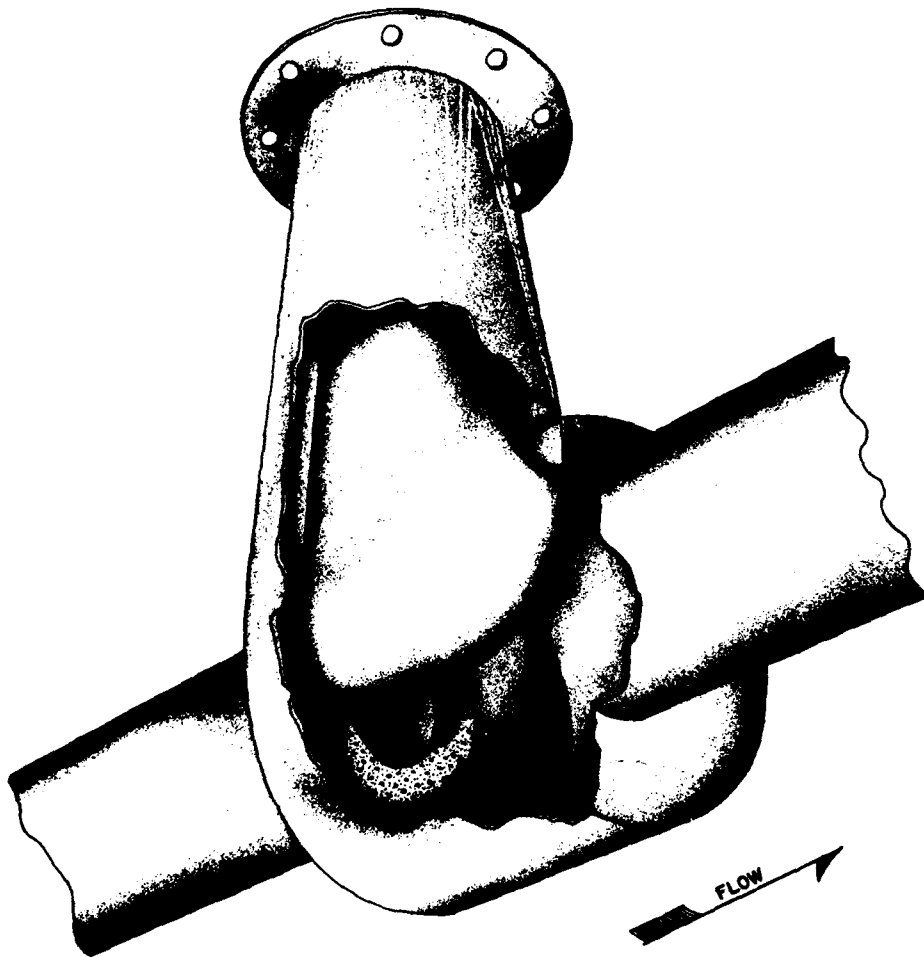


Figure 3.1 USANDL air-dilution valve.

designed to handle (waste paper, towels, swab rags, surgical dressings, wood, animal carcasses, human or animal organs, rubber gloves, rubber or plastic tubing, and animal pen debris, such as sawdust, feces, and vegetable matter). To eliminate the charge composition as a process variable, types of waste to be incinerated during this phase of the evaluation have been minimized and will include sawdust of known moisture content, and animal carcasses. Each experiment outlined in this test program will be performed on each of these wastes individually.

The limiting factor in the successful radiological operation of this system is the efficiency of the gas-cleaning system. Therefore, it is imperative that the combustion process be regulated to generate effluent matter that the gas-cleaning system can most efficiently remove from the exhaust gases. Variables that will be investigated to determine combustion conditions for optimum gas-cleaning efficiency are: furnace temperature; air-gas ratios and rates of the auxiliary fuel supply; and auxiliary combustion air rates, velocities, and angle of entry. These variables will affect burning rate, combustion efficiency, particulate size distribution in the effluent gases, dust loadings into the cyclone, ESP, and final filter. Variables affecting the gas-cleaning system are dust loadings, cyclone-inlet velocity, flow rate and temperature through the ESP, ESP output voltage, and flow rate through the high-efficiency filters.

The results of this phase of the test program are expected to define (a) fractional and overall cleaning efficiencies of each cleaning unit and of the entire gas-cleaning system; (b) optimum operating conditions of the incinerator and gas-cleaning system for each type waste; and (c) the overall weight reduction of each type waste, under optimum conditions.

5. STANDARDIZATION EXPERIMENTS

5.1 Objectives.

Prior to initiation of the test program to determine the effects of operating variables on combustion and gas-cleaning efficiencies, a series of standardization experiments will be conducted with each of the two types of waste to establish the reliability of sampling and analysis techniques, and to determine the reproducibility of various process measurements.

5.2 Procedures.

The conditions to be fixed and maintained for these experiments are: (a) waste composition, i.e. sawdust of known moisture content and animal carcasses; (b) incinerator effluent temperature; (c) burner air and gas rates in stoichiometric ratio; (d) horizontal auxiliary air inlets without annular inserts; (e) primary auxiliary air rate at 50 percent excess

air for combustion; (f) dilution air rate; (g) cyclone-inlet temperature; (h) cyclone-inlet velocity; and (i) ESP output voltage. Items (b), (c), and (e) will be determined by the composition of the waste to be incinerated, while items (f), (g), and (h) will be adjusted to give a design velocity of approximately 3500 linear feet per minute into the cyclone. Item (i) will be set at 17.5 kV.

Iso-kinetic samples will be collected before and after each gas-cleaning operation to determine dust-loading and weight-collection efficiency. Particulate samples, on membrane filters, will also be collected before and after each gas-cleaning operation to determine the fractional collection efficiency. Effluent gases will be sampled at the incinerator outlet and analyzed chromatographically for CO_2 , CO, O_2 , and N_2 to determine combustion efficiency.

Temperatures throughout the system will be measured with thermocouples and thermometers. Permanent records will be available with the thermocouple systems. Calibrated orifice meters and pitot-static tubes will be used for measuring system flow rates.

6. GAS-CLEANING SYSTEM EFFICIENCY EXPERIMENTS.

6.1 Objectives.

As stated previously, the limiting factor in the successful radiological operation of this facility is the efficiency of the gas-cleaning system. Consequently, the limitations of the gas-cleaning system must be defined in terms of fractional collection efficiency and overall weight-collection efficiency. Once these "limits" are established, it will be necessary to sample only the particulate matter from the incinerator outlet and analyze it for size distribution. Previous data of the fractional- and overall-weight-collection efficiencies of the cyclone, ESP, and filters will permit calculation of the weight and size range of particulate that will be removed by each unit.

The objectives of these experiments are to: (a) correlate cyclone fractional- and weight-collection efficiencies with cyclone-inlet velocity and dust-loading, and (b) correlate ESP fractional and weight-collection efficiencies with ESP inlet temperatures and ESP output voltages. With these correlations, the optimum ranges of cyclone-inlet velocities and ESP operating voltages for maximum gas-cleaning efficiency will be established.

6.2 Procedures.

Auxiliary combustion air and dilution air rates will be adjusted to attain approximate design velocity into the cyclone. Then dilution air rates will be varied to attain cyclone-inlet velocities ranging from approximately one-half below to one-half above design velocity. Concurrently the ESP output voltage will be varied from 10 to 20 kV. Flow rates through the final filters will depend upon the flow through the cyclone and ESP.

7. OVERFIRE AIR EXPERIMENTS

7.1 Objectives.

The advantages offered by the design of this facility's combustion chamber over that of previous incinerators are detailed in Reference 1. Briefly, these advantages are attributable to overfire (above grate) combustion-air entry; tangential entry of combustion air; and the capability to vary the combustion-air rate, velocity, and angle of tangential entry (either horizontal or 30° downward from the horizontal). The objectives of these experiments are to establish a correlation of the auxiliary-air-inlet rate, velocity, and angle of entry with incinerator effluent particle size distribution, dust loading, combustion efficiency, and gross burning rate. The results of these investigations will determine the appropriate operating conditions for optimum combustion efficiency and gas-cleaning efficiency.

7.2 Procedure.

As in the previous experiment, the two standard types of waste will be incinerated during these investigations. Tangential auxiliary air rates will be varied from 40- to 90- cubic feet per minute in the primary combustion chamber, and 20- to 45- cubic feet per minute in the secondary combustion chamber. Inlet velocities into the primary and secondary combustion chamber will be varied by positioning annular inserts of various diameters in the air-inlet pipes and will range from Reynolds Numbers of approximately 10,000 to 100,000. The procedures described above will be followed for both horizontal and 30° downward auxiliary-air inlets.

Sampling and analysis techniques employed during these experiments will be identical to those described in Section 5.3.2.

8. TEMPERATURE EXPERIMENTS

8.1 Objectives.

These experiments will establish a correlation of incinerator operating temperature and temperature-control mechanism (control on primary combustion-chamber burner or secondary chamber burner) with effluent particle size distribution, effluent-dust loadings, combustion efficiency, and gross burning rate. Appropriate temperature-operating conditions for optimum combustion efficiency and gas-cleaning efficiency will result from these experiments.

8.2 Procedures.

Tests performed during these experiments will, again, utilize the two fixed composition charges. Auxiliary-air and dilution-air rates will be adjusted to yield approximate design velocities throughout the system. Temperature controller set point will be varied from 1400°F to 2000°F for both controlling orientations (burner control in primary or secondary chamber). Sampling and analysis techniques employed will be identical to those previously described.

Part III PROPOSED RADIOLOGICAL AND ISOTOPIC EVALUATION

9. BACKGROUND

Results of the engineering evaluation program will define the optimum operating conditions for the facility. These operating conditions will be employed during the radiological and isotopic evaluation.

Specific isotopes will be utilized to determine the efficiency and maximum radioactive charge of the incinerator. The isotopes Sr^{89} , Ra^{226} , and I^{131} , have been chosen because of their nature and wide usage by the Army and AEC.

9.1 Objectives.

During this phase of evaluation, decontamination factors* (DF's) for the particular isotope(s) being used, will be determined for the incinerator, cyclone, electrostatic-precipitator, and mineral filters. An overall DF will be determined for the facility.

*Decontamination factor is the ratio of input activity to output activity.

Additionally, a determination will be made for each isotope, of the maximum level of activity in the charge that can be safely handled by the facility without exceeding maximum permissible concentration (MPC) limits for the particular isotope(s) as set forth in the Federal Register Part 20, "Standards for Protection Against Radiation."

9.2 Procedures.

For the phase utilizing radioactive materials, known quantities and combinations of the aforementioned isotopes will be injected in liquid form by means of a hypodermic syringe into sealed packages containing weighed samples of sawdust. The amounts are contingent on the limits of detectability, and will be varied initially from 10 μ c/kg of waste to a maximum of 200 μ c/kg of waste in increments of 10 μ c/kg.

These contaminated charges will be incinerated, and samples of the effluent particulate will be obtained before and after each gas-cleaning operation. Ash samples and filter samples will be assayed to permit determination of DF's.

Ash will be discharged from the incinerator, cyclone, and electrostatic precipitator during shut-down periods, into 55-gallon drums for ultimate disposal. The radiation level of ash residue will be surveyed after each discharge into the drum to prevent accumulation of hazardous radiation levels to personnel. All samples will be monitored with appropriate beta-gamma survey instruments to determine hazard to operating personnel. Normal radiation safety procedures and safeguards will be employed during the radiological evaluation.

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